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Evaporation Memorandum No. 21

# Geostrophic drag coefficient, roughness length and Davenport's index for 20 x 20 Km squares covering Great Britain

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In the simple system for interpolating 7-day averages of wind speeds, measured at or about 10 metres above the ground, to a regular grid of squares covering Great Britain, (Wales-Smith and Arnott, 1979) a surface roughness scale proposed by Davenport (1960) was supplied to staff of meteorological observing stations who were asked, thereby, to classify their sites and the immediate (5 mile radius) environs thereof. The method of using Davenport's index c was based on that proposed by Helliwell et al (1971).

Values of geostrophic drag coefficient ($C_D$ (x $10^{-4}$)) for 10 x 10 Km squares covering Great Britain were subsequently estimated in the Boundary Layer research branch of the Meteorological Office and these have now been averaged to a 20 x 20 Km grid (Figure 1). A rough relationship was established between the geostrophic drag coefficient and Davenport's index following advice from Smith (1979) and this is given in Table 1 which with Figure 1 allows $C_D$ (x $10^{-4}$) to be converted to C on 20 x 20 Km resolution, as required for the further development of the evaporation calculation system described by Wales-Smith and Arnott (1979).

Using a second relationship, supplied by the Boundary Layer Branch (Figure 2 and Table 2) $C_D$ (x $10^{-4}$) can be converted to $Z_o$ (roughness length) as required in the evaporation calculation system.

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References


| | | |
|---|---|---|
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| Helliwell et al | 1971 | Personal communication from Climatological Services Branch, Meteorological Office. |
| Smith, F. B. | 1979 | Personal communication. |
| Wales-Smith, B. G. and Arnott, J. A. | 1979 | The evaporation calculation system used in the United Kingdom WMO (in press). |

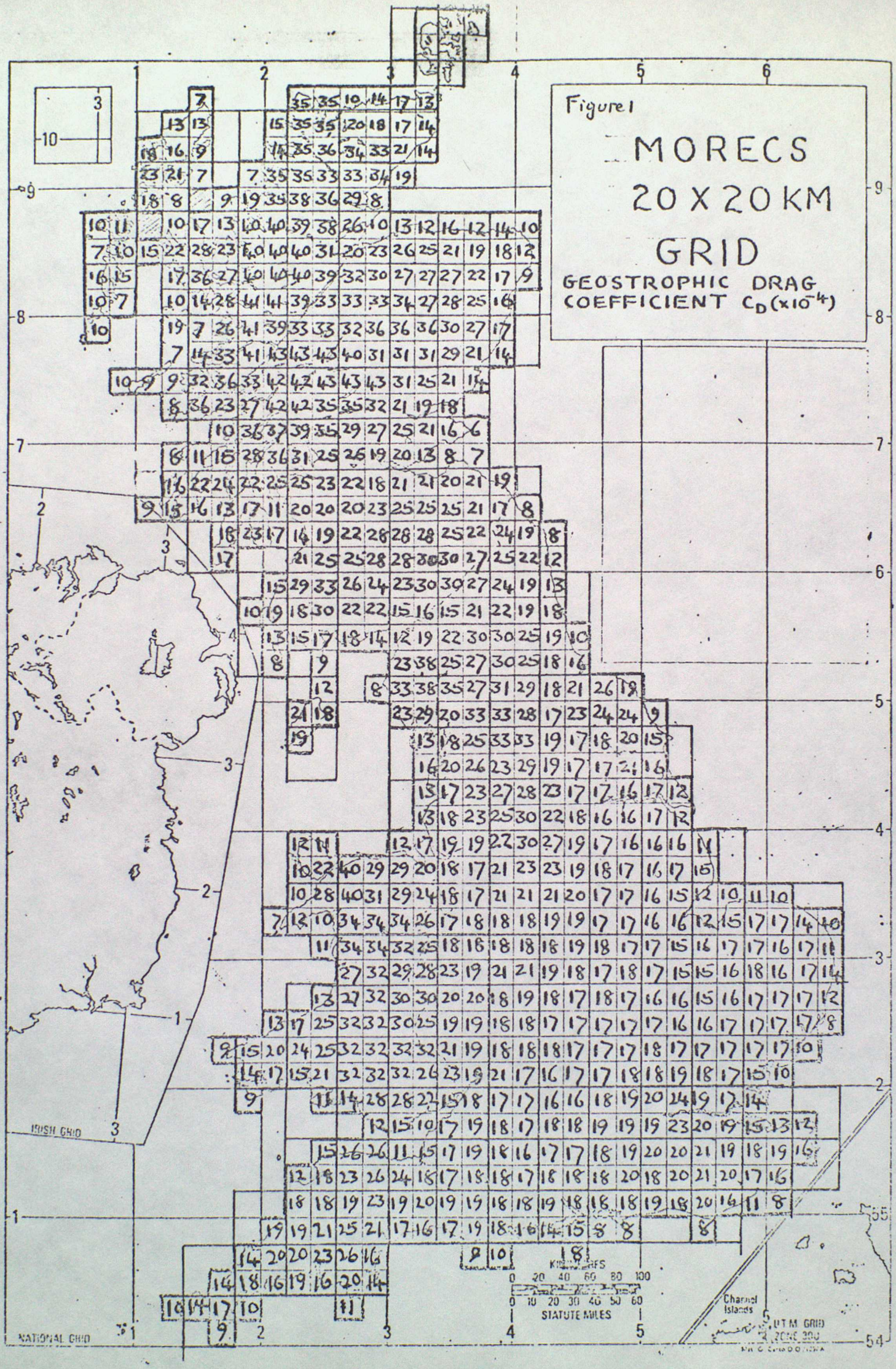
Figure 1
MORECS
20 X 20 KM
GRID
GEOSTROPHIC DRAG
COEFFICIENT $C_D$ ($\times 10^{-4}$)
IRISH GRID
NATIONAL GRID
KILOMETRES
0 20 40 60 80 100
0 10 20 30 40 50 60
STATUTE MILES
Channel Islands
UTM GRID
ZONE 30U

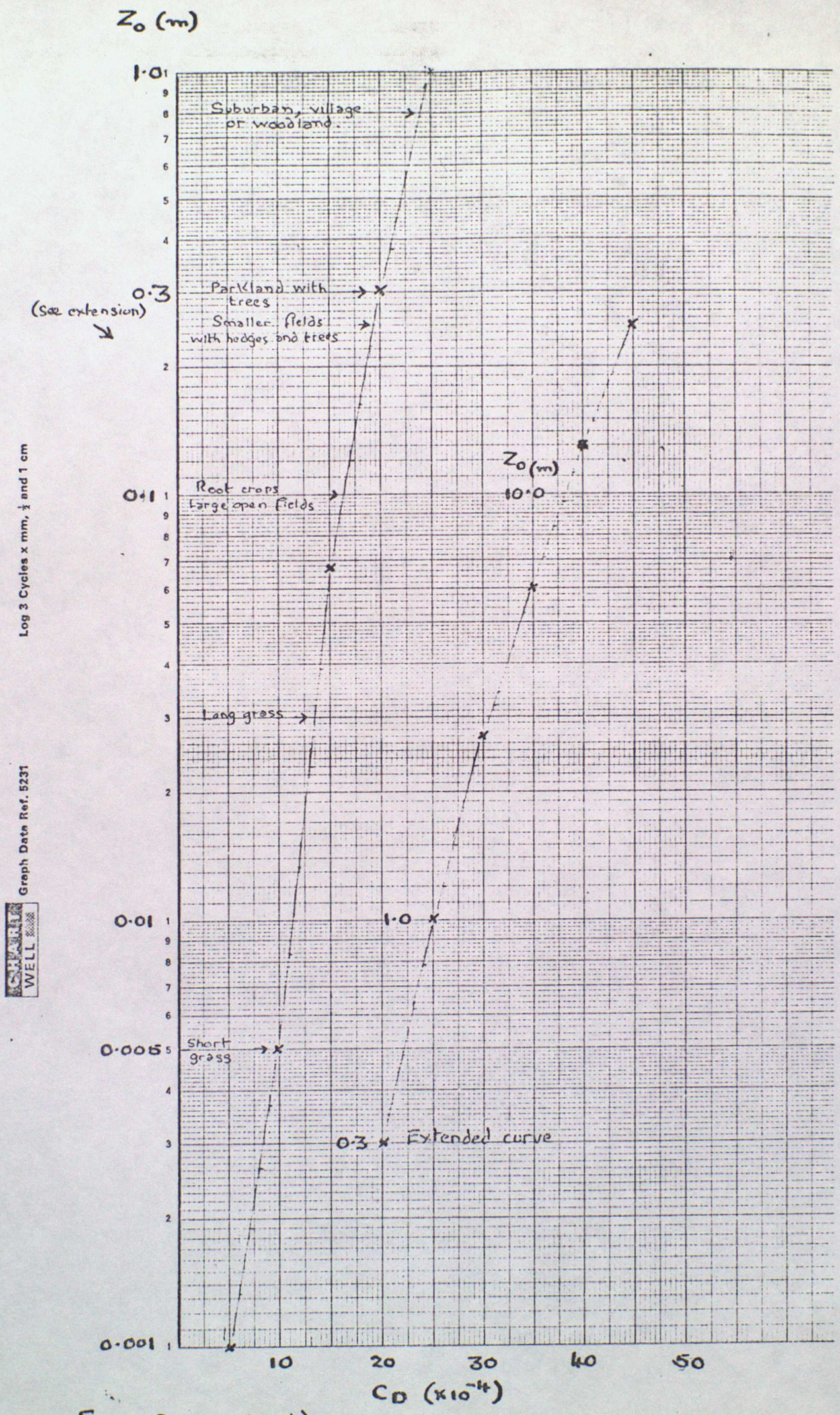


Figure 2. $C_D(\times 10^{-4})$ vs $Z_o$

Table 1.

Approximate relationship between Geostrophic Drag Coefficient and Semi-empirical terrain roughness index c

| $C_D$ ($\times 10^{-4}$) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| c | | | | | | | | 1 | 1 | 1 |
| $C_D$ | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| c | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 | 5 |
| $C_D$ | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| c | 5 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 |
| $C_D$ | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |
| c | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| $C_D$ | 40 | 41 | 42 | 43 | 44 | 45 | | | | |
| c | 9 | 9 | 9 | 9 | | | | | | |

Table 2.

GEOSTROPHIC DRAG COEFFICIENT VS ROUGHNESS LENGTH

| $C_D$ ($\times 10^{-4}$) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| $z_0$ (m) | | | | | | ·001 | ·002 | ·003 | ·004 | ·005 |
| $C_D$ | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| $z_0$ | ·005 | ·008 | ·013 | ·023 | ·039 | ·067 | ·090 | ·120 | ·162 | ·224 |
| $C_D$ | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| $z_0$ | ·300 | ·380 | ·480 | ·620 | ·780 | 1·00 | 1·20 | 1·50 | 1·83 | 2·30 |
| $C_D$ | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |
| $z_0$ | 2·70 | 3·20 | 3·80 | 4·40 | 5·2 | 6·0 | 7·1 | 8·4 | 9·6 | 11·2 |
| $C_D$ | 40 | 41 | 42 | 43 | 44 | 45 | | | | |
| $z_0$ | 13·0 | 14·8 | 17·0 | 19·4 | 22·2 | 25·0 | | | | |